

## REMARKS

### Rejections Under 35 USC §102 and 35 USC §103

Claims 1, 2, 4, 5, 9-11, 13-17 and 58-64 have been rejected under 35 USC §102(e) as being anticipated by Yew (US Patent No. 6,137,164).

Claims 9-13 have been rejected under 35 USC §103(a) as being unpatentable over Hanoaka (200220030245).

The rejections under 35 USC §102 and 35 USC §103 are traversed for the reasons to follow.

### Summary of the Invention

Claims 1-18 are directed to a semiconductor package (50-Figure 2A). Claims 58-64 are directed to an assembly (130-Figure 8A) that includes the package (50).

The package 50 (Figure 2A) includes a substrate 54, a semiconductor die 52 mounted to the substrate 54, and an encapsulant 48 molded to the substrate 54 encapsulating the die 52. The substrate 54 includes die contacts 86 that are placed in electrical communication with bond pads 60 on the die 52. The substrate 54 also includes conductors 72 (Figure 2B) and bonding sites 66 in electrical communication with the die contacts 86.

The package 50 (Figure 2A) also includes external contacts 84 on the bonding sites 66 arranged in a dense array, and configured as input/output ports for the package 50. The external contacts 84 comprise multi layered metal bumps that include a base layer 88 (first layer) on the bonding sites 66, a bump layer 90 (second layer) on the base layer 88, and an outer layer 92 (third layer) on the bump layer 90. The base layer 88 comprises a metal such as copper, that adheres to the bonding sites 66, which can also comprise copper. The bump layer 90 comprises a metal such as nickel, that can be easily deposited to a desired

thickness on the base layer 88. The outer layer 92 comprises a non-oxidizing metal, such as gold, that will bond easily to mating electrodes 136 (Figure 8B) on a supporting substrate 132 (Figure 8B).

In addition to the external contacts 84 comprising multi layered metal bumps, the die contacts 86 can also comprise multi layered metal bumps having substantially the same configuration. This configuration allows the die 52 to be more easily flip chip bonded than with conventional solder balls or balls (i.e., C4 process).

#### Argument

A semiconductor package having external contacts 84 (Figure 2A) with the claimed configuration is submitted to be novel and unobvious over the art. In particular, the cited prior art teaches semiconductor packages having external contacts in the form of solder balls or bumps. On the other hand, the presently claimed package includes external contacts in the form of multi layered metal bumps. The multi layered metal bumps can be made smaller, and more closely spaced than conventional solder balls, which decreases the overall thickness of the package. In addition, the metal bumps have a pyramidal shape with a planar tip portion, that more easily bonds to mating electrodes on a supporting substrate, than solder balls or bumps having a convex shape.

The claimed semiconductor package also includes die contacts 86 (Figure 2A) which are also configured to reduce the overall thickness of the package and to facilitate bonding between the package substrate 54 (Figure 2A) and the die 52 (Figure 2A). The combination of die contacts 86 (Figure 2A) and external contacts 84 (Figure 2A) having the feature of planar tip portions, is submitted to further distinguish the claimed package from the prior art.

Independent claims 1, 9, 14, 58 and 62 have been amended to include additional limitations which emphasize the features which patentably distinguish the claimed package from the prior art.

Independent claim 1 has been amended to recite "each external contact having a height H on the substrate equal to a combined thickness of the bonding site, the first metal layer, the second metal layer and the outer layer". Antecedent basis for this recitation is contained in Figure 2A, and in the specification on page 10, line 33 and on page 17, lines 2-7. Claim 1 has also been amended to recite "the height H selected to reduce an overall thickness T1 of the package to between about 0.1 mm to 1.4 mm." Antecedent basis for this recitation is contained on page 10, line 35, to page 11, line 3, of the specification. The additional recitations are submitted to make claim 1 both novel and unobvious over the prior art.

In Yew et al. the external contacts for the package are in the form of solder balls 440 (Figure 4A). As discussed at page 4, lines 1-19 of the present specification, conventional solder balls make a package thicker and larger. In Abbott et al. the external contacts are in the form of composite bumps 805 (Figure 6a) comprising a core 801 (Figure 6a) having metal layers 802/803. Although Abbott et al. discloses multi layered external contacts, there is no suggestion of external contacts configured to decrease the package thickness relative to conventional solder ball external contacts. In particular, Abbot et al. teaches a core 801 of about 0.9 mm (column 8, line 65) and a height of about 1.0 mm (Figure 8). As shown in Figure 6B of Abbott et al., the overall thickness of the package appears to be much greater than the height of the composite bumps 805. The presently claimed package exhibits an insight running contrary to the

teachings of the prior art, which is an indicia of unobviousness.

Independent claim 9 recites the external contacts and the die contacts in combination. In addition, claim 9 has been amended to recite "each die contact and each external contact comprising a generally pyramidal shaped multi layered metal bump having a planar tip portion configured to facilitate bonding to the substrate". Antecedent basis for this recitation is contained on page 7, lines 6-9 of the specification. Hanaoka et al. was cited as teaching projections 20 (Figure 1) having a pyramidal configuration. However, Hanaoka et al. also teaches external contacts 24 in the form of hemispherical solder balls on the projections 20 (paragraph 173). In addition, there is no suggestion in Hanaoka et al. of a multi layered pyramidal structure for bonding both a die to the substrate, and the substrate to a supporting substrate (e.g., PCB).

Dependent claim 12 has been amended to recite "a height H of each die contact and each external contact is about 5  $\mu\text{m}$ ." Antecedent basis for this recitation is contained on page 17, lines 2-4 of the specification.

Independent claim 14 recites both the die contacts and the external contacts in combination with "planar tip portions". In addition, claim 14 has been amended to recite that the planar tip portions of the external contacts are "configured to facilitate bonding of the package to a supporting substrate". Independent claim 14 has also been amended to recite "the external contacts having a height H on the substrate selected to reduce an overall thickness T1 of the package to between about 0.1 mm to 1.4 mm". In view of the additional limitations, claim 14 is submitted to be allowable for essentially the same reasons as claims 1 and 9.

Independent claim 58 has been amended to recite each external contact comprises a "generally pyramidal shaped

multi layered metal bump having a planar tip portion configured to facilitate bonding to an electrode on the supporting substrate". In view of the additional limitations, claim 58' is submitted to be allowable for essentially the same reasons as claim 9.

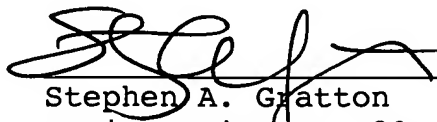
Independent claim 62 recites die contacts and external contacts with planar tip portions in combination. Claim 62 has also been amended to recite "each external contact having a height H on the substrate equal to a combined thickness of a bonding site and a multi layer metal bump, the height H selected to reduce an overall thickness T1 of the package to between about 0.1 mm to 1.4 mm. In view of the additional limitations, claim 62 is submitted to be allowable for essentially the same reasons as claims 1 and 9.

#### Conclusion

In view of the amendments and arguments, favorable consideration and allowance of claims 1-18 and 58-64 is requested. Should any issues remain, the Examiner is requested to contact the undersigned by telephone.

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Respectfully submitted:

  
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